

Application No.: 10/761,993

Docket No.: JCLA12335

REMARKS**Present Status of the Application**

The Office Action rejected all presently-pending claims 1-18. Specifically, the Office Action rejected claims 1-9 under 35 U.S.C. 103(a) as being unpatentable over Ji (US 6,787,409) and admitted prior art. The Office Action also rejected claims 10-18 under 35 U.S.C. 103(a) as being unpatentable over Ji and admitted prior art and further in view of Huang (U.S. 6,653,203).

Applicant has amended claims 1 and 10 and newly added claims 19-22 to more clearly define the present invention. The limitations added in claims 1, 10 and 19-20 are described in [0027] and the limitation described in claims 21-22 is as shown in Fig. 2C. It is believed no new matter is entered. After entry of the foregoing amendments, claims 1-20 remain pending in the present application, and reconsideration of those claims is respectfully requested.

Discussion of Office Action Rejections

Applicant respectfully traverses the rejection of claims 1-9 under 35 U.S.C. 103(a), as being unpatentable over Ji (US 6,787,409) and admitted prior art because a prima facie case of obviousness has not been established by the Office Action.

To establish a prima facie case of obviousness under 35 U.S.C. 103(a), each of three requirements must be met. First, the reference or references, taken alone or combined, must teach or suggest each and every element in the claims. Second, there

Application No.: 10/761,993**Docket No.: JCLA12335**

must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to combine the references in a manner resulting in the claimed invention. Third, a reasonable expectation of success must exist. Moreover, each of the three requirements must “ be found in the prior art, and not be based on applicant’s disclosure.” See M.P.E.P. 2143, 8th ed., February 2003.

The present invention is in general related a manufacturing method of a shallow trench isolation structure as claim 1 recites:

Claim 1. A manufacturing method of a shallow trench isolation (STI) structure, the method comprising:

providing a substrate, wherein a patterned pad oxide layer and a mask layer are formed on the substrate, and at least a trench is formed in the substrate, wherein the trench is formed by exposing a portion of the pad oxide layer and the mask layer;

forming a liner layer on a surface of the trench;

performing a high density plasma chemical vapor deposition (HDP-CVD) process to form an isolation layer comprising a first layer and a second layer on the substrate and over the trench, wherein the trench is completely filled with the isolation layer, wherein the high density

Application No.: 10/761,993

Docket No.: JCLA12335

plasma chemical vapor deposition (HDP-CVD) process comprises a first stage process for forming the first layer and a second stage process for forming the second layer, and *a bias power of the second stage process is higher than a bias power of the first stage process, and a deposition to etching ratio of the second stage process ($d2/e2$) is lower than a deposition to etching ratio of the first stage process ($d1/e1$), wherein the second layer is denser than the first layer;*

removing the isolation layer over the trench;

removing the mask layer; and

removing the pad oxide layer.

Ji fails to teach or suggest the second layer formed by the second stage process is denser than the first layer formed by the first stage process. The office action points out the Ji reference has disclosed the two layers deposited by the first and second stage process have a different etch rate of about 10%. However, Ji just discloses the etch rates of bulk oxide layer and oxide liner are within about 10% of one another (see col. 5, lines 58-60), but he does not teach which layer has higher or lower etch rate. In the present invention, the second layer formed by the second stage process is denser than the first layer formed by the first stage process, and thus the first layer has an etch rate higher than the second layer because a layer having denser material is harder to etch. Because Ji and the admitted prior art do not teach or suggest the second layer formed by the second stage process is denser than the first layer formed by the first stage process. The two references combined do not teach or suggest each and every element in claim 1.

Application No.: 10/761,993

Docket No.: JCLA12335

In addition, the office action points out the mask layer and pad oxide layer in the Ji reference are not removed because they are used to form gates, but it is not necessary to be used for forming gates, it also can be simply function as a stop layer for planarization step. However, a divot around the corner of the trench is not generated during the planarization step (CMP process), but the divot is usually formed during the step of removing the mask layer and pad oxide layer. In other words, in the Ji reference the problem of divot formation around the trench is not existed, but a groove 8 may generate when etching back the bulk oxide layer 20 and the liner layer 19 formed in the trench (as shown in Fig. 1). The method provide by Ji is used to resolve the problem of a groove forming when etching back the bulk oxide layer and the liner layer. In holding an invention obvious in view of a combination of references, there must be some suggestion, motivation, or teaching in the prior art that would have led a person of ordinary skill in the art to select the references and combine them in the way that would produce the claimed invention (*Karsten Mfg. Corp. v. Cleveland Golf Co.*, 242 F.3d 1376, 1385 (Fed. Cir. 2001)). When the references are in the same field as that of the applicant's invention, knowledge thereof is presumed. However, the test of whether it would have been obvious to select specific teachings and combine them as did the applicant must still be met by identification of some suggestion, teaching, or motivation in the prior art, arising from what the prior art would have taught a person of ordinary skill in the field of the invention (*In re Dance*, 160 F.3d 1339, 1343 (Fed. Cir. 1998)).

For at least the foregoing reasons, Applicant respectfully submits a prima facie case of obviousness for claim 1 has not been established by the Office Action. Independent claim 1

Application No.: 10/761,993

Docket No.: JCLA12335

patently define over the prior art references, and should be allowed. For at least the same reasons, dependent claims 2-9 patently define over the prior art as a matter of law, for at least the reason that these dependent claims contain all features of their respective independent claim.

Applicant respectfully traverses the rejection of claims 10-18 under 35 U.S.C. 103(a), as being unpatentable over Ji and admitted prior art and further in view of Huang (U.S. 6,653,203) because a prima facie case of obviousness has not been established by the Office Action.

The present invention also provides a manufacturing method of a shallow trench isolation structure as claim 10 recites:

10. A manufacturing method of shallow trench isolation (STI) structure, the method comprising:

providing a substrate, wherein a patterned pad oxide layer and a mask layer are formed on the substrate, and at least a trench is formed in the substrate, wherein the trench is formed by exposing a portion of the pad oxide layer and the mask layer;

performing an etch-back process to the mask layer to pull back the mask layer;

forming a liner layer on a surface of the trench;

performing a high density plasma chemical vapor deposition (HDP-CVD) process to form an isolation layer comprising a first layer and a second layer on the substrate and over the trench, wherein the trench is completely filled with the isolation layer, wherein the high density plasma chemical vapor deposition (HDP-CVD) process comprise a first stage process for forming the first layer and a second stage process for forming the second layer, *a bias power of*

Application No.: 10/761,993

Docket No.: JCLA12335

the second stage process is higher than a bias power of the first stage process, and a deposition to etching ratio of the second stage process ($d2/e2$) is lower than a deposition to etching ratio of the first stage process ($d1/e1$), wherein the second layer is denser than the first layer;

removing the isolation layer over the trench;

removing the mask layer; and

removing the pad oxide layer.

As discussed as above, Ji and the admitted prior art fail to disclose, teach or suggest the feature of the second layer formed by the second stage process is denser than the first layer formed by the first stage process. Huang also fails to teach or suggest the feature of the second layer formed by the second stage process is denser than the first layer formed by the first stage process. The references combined do not teach or suggest each and every element in claim 10.

For at least the foregoing reasons, Applicant respectfully submits that independent claim 10 patently define over the prior art references, and should be allowed. For at least the same reasons, dependent claims 11-18 patently define over the prior art as a matter of law, for at least the reason that these dependent claims contain all features of their respective independent claim.

Newly added claims

Applicant has newly added claims 19-20 which comprise the limitation of the deposition rate $d2$ in the second stage process is equal to the deposition rate $d1$ in the first stage process, and the etching rate $e2$ in the second stage process is larger than the etching rate $e1$ in the first stage

Application No.: 10/761,993**Docket No.: JCLA12335**

process. The feature is not disclosed in the prior art references. In the present invention, the deposition to etching ratio of the second stage process is lower than that of the first stage process, the decrease of the ratio is due to the increase of the etching rate, and the deposition rate is not changed between the first and second stage process. Accordingly, the throughput of the process will not be reduced.

In addition, applicant has further newly added claims 21-22 which comprise the limitation of the first layer formed by the first stage process is non-conformal. As shown in Fig. 2C of the application, the first layer 212 formed by the first stage process is non-conformal. In details, the thickness of the first layer formed on the sidewall of the opening is thinner while the thickness of the first layer 212 on the bottom of the opening is thicker. On the contrary, in the Ji reference the layers 16, 18 are conformal (see col.4, lines 44-46 and col. 4, lines 59-61). Because the first layer is non-conformal, that is the first layer formed on the sidewall of the opening is thinner than that formed on the bottom of the opening, the second layer formed subsequently can be easily filled into the opening. In other word, the structure after forming the first layer the in the present invention has better aspect ratio.

Application No.: 10/761,993

Docket No.: JCLA12335

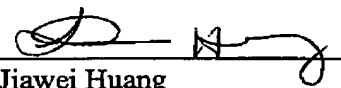
CONCLUSION

For at least the foregoing reasons, it is believed that the pending claims are in proper condition for allowance. If the Examiner believes that a telephone conference would expedite the examination of the above-identified patent application, the Examiner is invited to call the undersigned.

Date: 4/6/2006

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